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ROUTINE AND VARYING PRACTICE AS PREPARATION FOR ADJUSTMENT TO A NEW SITUATION

BY
LELAND W. CRAFTS

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, in the faculty of Philosophy, Columbia University.

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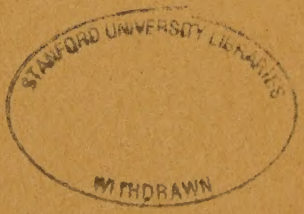

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Routine and Varying Practice as Preparation for Adjustment to a New Situation

INTRODUCTION

The aims of this investigation are:

(1) To compare the value, from the viewpoint of subsequent initial adjustment to a new situation, of two kinds of practice:

a. Practice under *constant* conditions, i.e., in reacting to situations which remain continually the same, and

b. Practice under *varying* conditions, i.e., in reacting to situations which are throughout varying and changing.

(2) In case differences appear in the relative value of these two kinds of practice in different kinds of situations, to discover the particular conditions responsible therefor.

By "new situation" is meant one similar in a general way to those in which the practice took place, but different from all of the latter in certain of its specific details or elements.

Since the effect of previous practice upon adjustment to a situation recognizably different from the practice situations is commonly termed transfer of training, the present investigation may be classified as being a study in that field. From this viewpoint the problem becomes the comparison and the analysis of the immediate transfer value of practice under constant and under varying conditions.

Since the situations employed for both the practice or training, and the new or test situations were card sorting, simple and complex substitution tests and typewriting only, any generalizations that may be drawn from the results are limited in their applicability to simple situations of this type, i.e., to situations which in the main evoke responses of the sort commonly classified as sensori-motor and in which a considerable mastery of the reactions involved can be secured by

a very brief period of practice. It therefore follows that the problems stated above, although phrased there in very general terms, are in point of fact limited in their scope to situations and responses of this restricted type.

The procedure employed throughout the study was, in its general outlines, always the same regardless of the nature of the situations or materials used. All of the subjects, whether those working at card sorting, or at typewriting, or in substitution tests, were always given the same initial practice or test, and were then divided into two groups equated on the basis of their scores thereon. Then one group continued practice under the constant, the other under the varying condition. Finally, both groups were given the same "final test" in the "new situation." The change in score, computed in per cent terms, from the initial to the final test, was considered to constitute a measure of the effect of the intervening practice and so of the transfer value of the latter.* Comparison of the average per cent changes in score obtained by the constant and by the varying groups then revealed the relative efficacy of these conditions of practice as preparation for adjustment to the final, new situation.

So far as the writer is aware, this problem as to the respective transfer value of routine and variation in practice is very nearly unique. It is, however, analogous to such a one as: Which is of more value for the development of a concept, reaction to many or to a few different situations each of which contains the essential common elements to which the concept may be considered a response? This question seems to receive from psychologists only one answer; namely, that variation in the total situations presented is indispensable. Gates,[7] for example, speaking of the method best adapted to develop such an abstract idea as that of squareness, avers that one must show a child "many different gross totals which contain it, a square card, a square desk, a square block, a square board, drawing, picture, etc." This advice is given without

* The change in score may, of course, be in part due to the practice in the initial test itself, and so may not, strictly speaking, always be brought about by the intervening practice alone. Since, however, our problem does not concern either the presence or absence of transfer effect, or its absolute magnitude if found, but instead only the relative preparatory values of two modes of practice, the fact that some of the so-called transfer effect may be attributable to work on the initial test in no way affects the validity of our method.

critical qualification or comment just as if it were supported by ample experimental evidence. But, as a matter of fact, the evidence is far more common sense, anecdotal and logical in nature, than it is the product of controlled research. Hull,[8] to be sure, in his study on the evolution of concepts, has dealt with precisely this problem. Using complex Chinese characters as his "total situations," and a specific group of marks contained in each as the common element to which the reaction, in this case the articulation of a particular nonsense-syllable, was to be developed, he compared the speed of acquiring this association in subjects who were presented with six, and subjects who were presented with only three, "concrete cases," i.e., different complex characters. From the results obtained he concludes: "A moderate amount of practice spent upon each of six concrete cases is perceptibly more efficient in the evolution of functional concepts than twice as much time spent upon each of three concrete cases." But since these are the only laboratory data bearing directly upon the question, it seems permissable to conclude that further studies in the field, even though they but confirmed present conclusions, would by no means be devoid of value.

The present investigation, however, has this element of novelty. In so far as the question of the relative value of routine versus variation in practice has been raised at all, it has been advanced only in connection with the concept. That is, theory and research have been confined almost solely to the assertion, and in some degree to the proof, of the superior value of variation in developing verbal responses of the kind habitually interpreted as being essentially subjective or mental in nature. But the present study deals with reactions which, being primarily movements of the eyes, arms, hands, and fingers are in the main indubitably motor. It remains to be seen whether variation in practice situations will be more profitable in this sphere also. With reference to this problem there are, in the general experimental literature, only two studies of Dashiell which are pertinent; and since these were not undertaken with any such problem in mind, their relevance is quite accidental.

The first study of Dashiell[6] mentioned above dealt with transfer factors in the maze learning of white rats. Among his experimental groups were two whose practice can be considered as having been, respectively, of the constant and of

the varying type; for one of these two groups was practiced upon a single maze until they made three runs without error, an achievement which usually required about sixteen trials, whereas the other had one trial with each of twenty-five different mazes on each of twenty-five different days. Finally both groups were tested upon a maze different from any with which they had previously practiced. The experiment was performed twice. The first time the two groups were about equal in performance in the test maze, whether the criterion thereof was the first trial or any subsequent one, or whether performance was scored in time or errors. When the experiment was repeated, however, the "varying" group was decidedly superior in the initial trial with the test maze, averaging only three errors as compared with seven made by the "constant" group, and requiring only 24 seconds as compared with 62. Hence, even though during the 24 trials with the test maze following the first the two groups showed little difference, the varying condition of practice seemed to possess a greater initial or immediate transfer value. Dashiell, however, does not in his discussion even mention the existence of this initial difference and naturally, therefore, has no explanation for it.

In his second study[5] mentioned as having some relevance to our problem, Dashiell had two groups of students practice at a simple digit-number substitution test four minutes a day for eighteen days. One group worked always with the same code or key, the other worked each day with a different one. On the nineteenth day each group was tested on a code different from any previously employed. The "varying" group scored thereon 140 substitutions, the "constant" 110. Dashiell's results therefore indicate that change is superior to routine in developing ability to adjust to a new substitution test situation, and so are in harmony with those obtained by Hull in his study of the concept (in so far, that is, as the two investigations may be considered comparable). There still remains, however, the problem as to whether similar results would be obtained with different material. And further, Dashiell's suggestion that the inferiority of the constant group is perhaps due to "wrong attitude . . . expecting and being used to the same code throughout" seems scarcely satisfactory. It is quite possible that controlled variations in the situations presented and the reactions demanded would yield data more

clearly indicative of the particular condition under which the varying practice is superior and so of the circumstances responsible for its advantage.

The exact nature of the variations employed by us in the varying condition probably requires some explanation, especially since the variation was in no sense haphazard or chance, but was instead rigidly controlled according to the following principles:

1. There was a change, at every trial from initial test to final test, of *all* the specific reaction elements. Hence the comparison between the constant and the varying conditions is between complete and continual routine on the one hand, and a continuous series of complete changes on the other; or, in other words, between constant and varying conditions, each in its most extreme and unmixed form.

2. With the exception of one part of Experiment III, the changes in the varying condition were so devised that, so far as possible, there was no greater similarity between any of the varying situations and the final test than there was between the one situation employed in the constant condition and the final test. I.e., the specific partial identities between practice and test situations were, objectively considered, no greater at any time for the varying than they were for the constant groups.

In variation not thus rigidly controlled, however, it could only be by chance that either of the two conditions above would be satisfied. One would, for example, expect that in uncontrolled variation the accidental recurrence of the same situations would at times establish practice conditions which would in some degree share the characteristics of both constant and varying ones. And further, one would also anticipate that some of the changing situations would, if uncontrolled, possess by chance partial identities with a final test situation of a degree and nature unlikely to be possessed by any one routine situation taken at random.

An illustration of the use of uncontrolled variation in practice is to be found in Ruger's[11] study of puzzle solutions. In one case he compared the effects of presenting and solving a puzzle (a) 250 times in "chance positions" and (b) 400 times

in four different positions only, followed by a test of 23 trials on the chance positions. The subject who had had the chance positions throughout was, at the end of his 250 trials, superior in solving in those positions to the subject who had had 400 trials with the four positions only. This result does not, however, disclose in any unambiguous way the relative transfer value to new situations of constant and varying conditions of practice. For the (b) condition above was not a constant condition purely, but instead involved variation as well as routine. And since the variations in the (a) condition were uncontrolled, it is entirely possible that the superiority of the (a) subject was due, not to the fact that his practice involved more variations, but to the fact that by chance some of the puzzle positions at the end of his series were identical with some of those which he had encountered earlier.

Unless variation is controlled in somewhat the fashion adopted in this experiment, the source and conditions of its value are likely to remain as uncertain as they were in Ruger's experiment cited above.

A word should perhaps be said with respect to terminology. By transfer, or transfer effect, or transfer value, or transfer of training we shall mean any effect of practice in reacting to one situation upon adjustment to another recognizably different one. Transfer effect which represents a gain in speed, accuracy, amount done, or any other measure of achievement will be termed positive; transfer effect which represents a loss in any of the above measures will be termed negative. By interference we shall mean the eliciting of antagonistic responses by simultaneously effective stimuli. This, it will be found, is commonly brought about when the reactions developed during the practice are inappropriate to work on the test, and is always productive of negative transfer effect.

By an element we shall mean simply a part or constituent of a whole. Hence elements may be stimuli when one is thinking of the discriminable parts of a total situation; responses when one is thinking of the part reactions of which a total act may be composed; and stimulus-response associations when one is thinking of the individual SR's out of which a total complex-situation-complex-response is constituted. Elements present in more than one situation or response total will be spoken of as being *common* to the situations, etc., containing them.

EXPERIMENT I

Problem. Which kind of practice yields the greater initial positive transfer effect to a new arrangement (in card sorting) or a new key (in a substitution test), practice under constant or under varying conditions?

By a "new arrangement" is meant one entirely different in all specific factors from any with which a subject has previously worked, i.e., one in which no card is sorted into any compartment to which it has ever before been assigned. Similarly, by a "new key" is meant one entirely different from any of its predecessors, i.e., one in which no number goes with any letter with which it has ever before been associated.

By constant conditions of practice is meant, of course, practice with one arrangement or key only previous to the final test on the new arrangement or key. By varying conditions is meant practice with continually changing arrangements of keys.

Subjects. Fifteen graduate students, eleven men and four women, Columbia University.

Procedure. A. Card Sorting

The *materials* used were as follows:

1. A wooden box of nine compartments, each compartment 4½ inches square, arranged in three rows of three each. The middle row was elevated above the front row, the back row above the middle row, so that, while the height of the front of the box was 3⅞ inches, that of the back was 11⅛ inches. Each compartment was labeled with some one number from 1 to 10 inclusive (except that 9 was omitted) by tacking to its rear side a flinch card bearing the appropriate number. For the preliminary practice, however, the labels, attached now to four compartments only, were the kings of the four playing-card suits.

2. Eighteen packs of flinch cards, each containing 72 cards equally divided among the nine numbers from 1 to 10 inclusive (9 being omitted).

3. One pack of ordinary playing cards containing 72 cards equally divided among the nine denominations from the ace to the ten-spot inclusive (the 9 being omitted).

The cards in every pack were always in the chance order that ordinary shuffling would yield, except that no two cards of the same number were allowed to appear in immediate sequence.

Method of Sorting. Instructions to Subjects

The following instructions were given, in typewritten form, to every subject:

"You will receive packs of cards, each card bearing upon it some number from 1 to 10 inclusive (except that "9" is omitted). These cards you are to sort into a box of 9 compartments. Each compartment will have upon it a number, indicating that that is the compartment into which all cards bearing that number are to be sorted or thrown.

"For the actual work of sorting you stand up, facing the box, at any distance from it convenient to you. Take the pack in your left hand (if you are right-handed). The box is now covered, the compartments hidden from view.

"When the signal to begin sorting is given, the box will be uncovered, disclosing the arrangement of the various numbers thereon, indicating into what compartments the various cards are to be sorted. With your right hand (if you are right-handed) sort or throw each card, as it comes in the pack, into its proper compartment. Use any method of throwing you wish. Begin work immediately when the above signal is given; your time is taken from that moment. If you make an error, go right ahead with the next card without delay. No correction of errors is allowed.

"The experiment proper is preceded by a preliminary sorting of ordinary playing cards to familiarize you with the general nature of the work and the handling of the cards. The playing cards are sorted according to suit into four compartments, each one marked by the king of some suit; i.e., all the spades are to be sorted into the compartment bearing the king of spades, etc. The method of work, timing, etc., is exactly the same as described for the sorting of the numbered cards above."

The "signal to begin" referred to in the instructions above was the removal of a sheet of cardboard from the top of the sorting box; it was always preceded by the word "ready" or some equivalent.

Time was taken, by means of a stop-watch, from the giving of that signal to the fall in the box of the last card of the pack. The speed for each sorting was the time thus determined plus one second for each error observed.

The interval between each sorting was one minute.

As to motivation, the subjects were told in a casual manner of their speed on each pack immediately after its sorting was completed, and their progress relative to their own past scores was occasionally commented upon. The experimenter made no attempt to develop any unusual degree of incentive, but since most of the subjects appeared to consider the work as a sort of psychological test possessing personal significance to them, it seems probable that, as a group, their motivation was satisfactory.

Each subject sorted each day 9 packs of flinch cards. Each subject also sorted 2 packs of playing cards as a preliminary test before the experiment proper began.

Procedure. B. Substitution Test

The *materials* were as follows:

1. Nine keys, each containing in a horizontal row the 9 letters, b, d, f, h, j, l, n, p, and r, always in the same, i.e., in alphabetical order, and below them a row of 9 numbers from 0 to 8 inclusive. These keys were typed on pieces of white cardboard of uniform size; small letters only were used; all the spacings were uniform. They were set up on a table in front of the subject, at any distance convenient to him, by inserting them upright in a slot in a wooden block. For a preliminary test one key was used, identical with the above except that the letters were c, g, k, m, q, s, t, w, and x.

2. Multigraphed practice sheets, each containing 72 of the appropriate letters arranged in 9 vertical columns of 8 letters each. Each of the 9 letters appeared 8 times on each sheet. Their order was chance except that no two of the same letter appeared in immediate sequence in any vertical row.

3. Soft lead pencils of uniform make and condition.

Methods of Work. Instructions to Subjects

The following instructions were given on a typewritten sheet to each subject:

"You will receive (1) a sheet of paper having printed on it 9 columns of single letters, and (2) a code or key, printed on cardboard, which shows the numbers that go with, or stand for, each of the various letters, and which will remain in front of you while you are at work.

"The actual work in the test is to write (with pencil) opposite to and to the right of each letter in the columns the number which goes with it in the key. For example, if in the key the number appearing directly below the letter "x" were 72, that would mean that beside every letter "x" in the columns you would write a "72."

"Before the signal to begin work is given, you will receive a sheet of the kind described above and a pencil. When the signal is given, the key will be placed in front of you, indicating what the numbers are that go with the letters on that sheet. Begin work immediately—your time is taken from the moment of the signal. Work as fast as possible but avoid errors. If you make an error, go right on to the next letter without delay. No correction of errors by erasure, or by any other change in a number once written, is allowed.

"Begin your work at the top of the left-hand column. Work down that column, then pass to the top of the next column to the right, work down that column, and so on. Work with each letter in order without skipping any."

The "signal to begin" referred to in the instructions above was the removal of a blank card which had previously concealed the key from view. This signal was always preceded by the word "ready" or some equivalent.

Time was taken, by means of a stop-watch, from the giving of the signal to the completion of the last digit substituted. The speed for each sheet was the time thus determined plus one second for each error made.

The interval between each sheet was one minute.

The motivation was, so far as could be observed, quite analogous to that which presumably obtained during the card sorting.

Procedure. C. Conditions Common to Both Card Sorting and the Substitution Test

DIVISION OF THE SUBJECTS INTO GROUPS

The 15 subjects were divided into two groups on the basis of the time required to sort the second of two packs of playing cards, and to complete the second of two substitution test sheets with the preliminary key.

The average times for the groups thus obtained were as follows:

	No. of Subjects	*Group 1 (Constant)*	*No. of Subjects*	*Group 2 (Varying)*
Card Sorting	7	86.6″	8	86.0″
Substitution on Test	7	110.7″	8	111.0″

The subjects who were in the constant group for card sorting were in the varying group for the substitution test, and vice versa.

Not only were the average times for the two groups approximately equal, but also it was possible to "pair" an individual of each group with an individual of the other.

The Practice Conditions

As we have said, in both the card sorting and the substitution test two conditions of practice were employed, the constant and the varying.

In the constant condition the subject each day sorted 8 packs with one arrangement only, or worked 8 sheets with one key only, and was then tested, for transfer effect, on a second arrangement or key different in all its specific elements from that used during the practice.

In the varying the subject also sorted each day 8 packs, or worked 8 sheets, but had for each pack or sheet an entirely different arrangement or key. He was then tested for transfer effect on a ninth arrangement or key different throughout from any of those employed during the practice. The restriction of the number of such all-different arrangements or keys to 9 was necessitated by the fact that the number of compartments in the box was 9 only, so that no one card could be assigned to more than 9 different compartments.

Both the final test arrangement or key and the arrangement or key immediately preceding it (i.e., the last of the

practice series) were the same each day and the same for both groups of subjects. The arrangements and keys used in the constant condition were the same each day. Those used in the varying were also the same each day, but were each day presented in a different order. Each arrangement or key was so constructed that no two numbers in any horizontal row appeared in the order in which they come in the numerical series; e.g., a "5" never followed a "4," nor an "8" a "7."

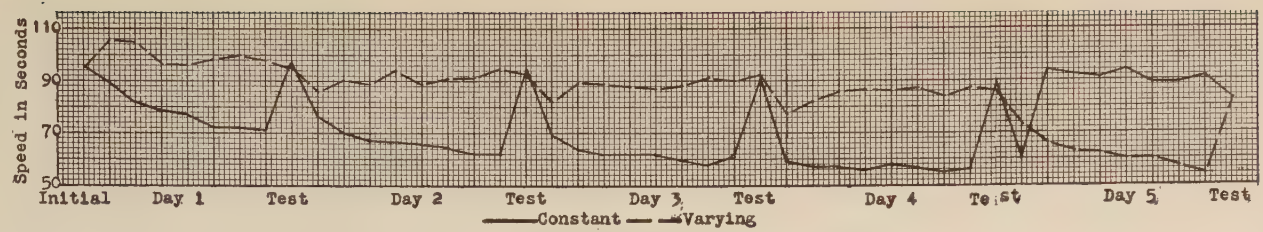
These conditions appeared adequate to ensure that each day each group would come to the final test for that day with practice approximately identical in amount, and likewise identical in kind save for this one difference: that in the constant groups it had been with arrangements or keys always identical in all specific elements, whereas in the varying groups it had been with arrangements and keys continually varying in all specific elements.

One of the presumably equal groups sorted cards under the constant and substituted under the varying condition; the other sorted under the varying and substituted under the constant condition. In each group the substitution test came first each day. The two groups worked for four successive days under the conditions to which they were originally assigned. On the fifth day, however, the conditions for each group were reversed, so that those who had been sorting or substituting under the constant condition now sorted or substituted under the varying, and vice versa.

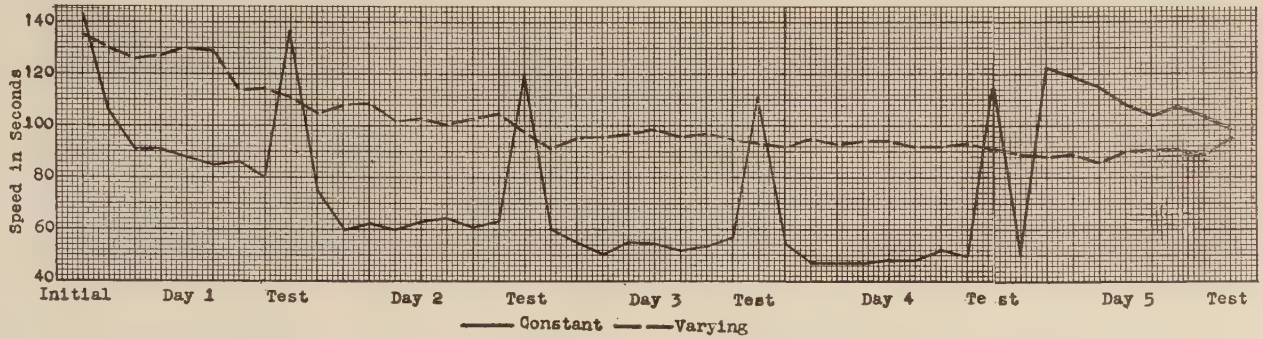
Results. Experiment I

The results of Experiment I are presented in the following graphs and tables.

Graph 1 gives the complete data for the card sorting; i.e., it shows the average speed, for both the constant and the varying groups, for each sorting each day in both the tests and the practice. The first sorting on the first day was considered to be the initial test; the ninth sorting on each day was the final test for that day; sortings one to eight on each day constituted that day's practice. Inspection of this graph shows: (1) With respect to the speed on the final tests, the difference between the two groups was at all times very slight and was, moreover, not significantly affected by the reversal



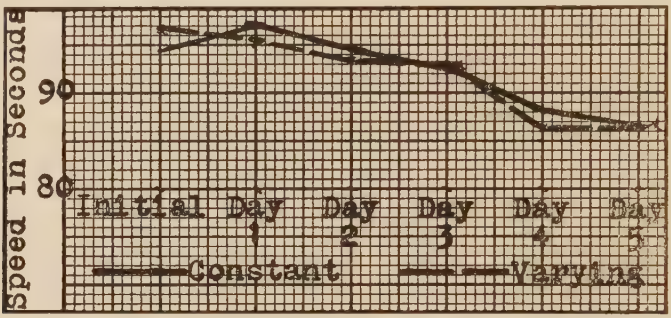
GRAPH 1. AVERAGE SPEED, CARD SORTING.



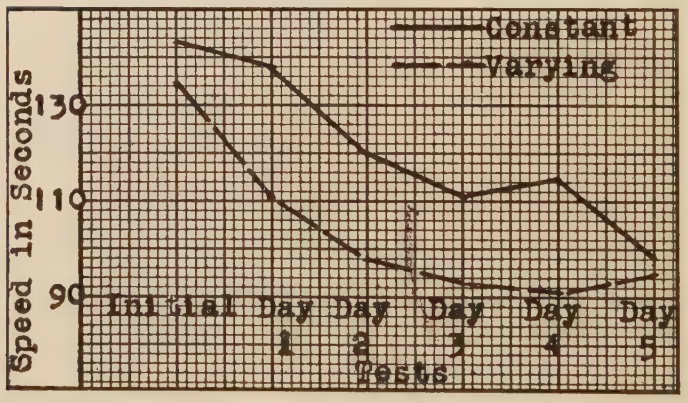
GRAPH 2. AVERAGE SPEED, SIMPLE SUBSTITUTION TEST.

of practice conditions on the fifth day. (2) The practice curve as a whole, i.e., the curve (exclusive of the daily final tests) for days one to four inclusive, was for the constant group of the familiar negatively accelerated type, but for the varying it was, although on the whole lower each day, very irregular and showed, within each day taken separately, a tendency to rise rather than to decline.

Graph 2 gives the same data for the substitution test. Inspection of this graph shows: (1) With respect to the speed on the final tests, the varying group was distinctly superior on days one to four inclusive, but on the fifth day, when practice conditions were reversed, its superiority was much diminished. (2) The practice curve taken as a whole was for the constant group of the negatively accelerated type; for the



Graph 3. Average Speed, Initial and Final Tests, Card Sorting.



Graph 4. Average Speed, Initial and Final Tests, Simple Substitution Test.

varying it was likewise negatively accelerated on days one and two, but on days three and four it showed, within each day taken separately, a tendency as much to rise as to decline.

Graph 3 shows, for the constant and the varying groups in card sorting, the average speed in seconds for the initial test on day one and for the final tests on each of the five days of practice. As before we note that the difference between the two groups was at all times very slight and was not significantly affected by the reversal of practice conditions on the fifth day.

Graph 4 presents the same data for the substitution test. Here we may again note that the varying group was at all times superior to the constant, but that its superiority was much diminished by the reversal of practice conditions on the fifth day.

TABLE 1

Card Sorting. Average speed in seconds, for both groups, for the initial test (the first sorting on the first day) and the daily final tests.

Group	*No. of Subjects*	*Initial Test*	*Daily Final Tests*				
			Day 1	*Day 2*	*Day 3*	*Day 4*	*Day 5*
Constant	7	94.9	96.9	94.8	91.2	88.2	83.3
Varying	8	96.7	95.2	93.5	91.6	86.6	83.4

Note that the difference in speed was at all times very slight, and that it was not significantly affected by the reversal of practice conditions on the fifth day.

TABLE 2

Substitution Test. Average speed in seconds, for both groups, for the initial test (the first trial on the first day) and the daily final tests.

Group	*No. of Subjects*	*Initial Test*	*Daily Final Tests*				
			Day 1	*Day 2*	*Day 3*	*Day 4*	*Day 5*
Constant	7	142.7	136.7	119.6	110.9	114.3	98.5
Varying	8	134.4	111.0	97.5	92.9	90.9	94.9

Note that the varying group was always superior to the constant, but that when practice conditions were reversed on the fifth day its superiority was greatly diminished.

TABLE 3

Card Sorting. Average per cent transfer effects for both groups for each of the five daily tests. The amount of transfer effect was computed by finding the differences in speed between the initial and the final tests and then finding what per cent these differences were of the speed on the former. The transfer was in all cases positive.

	Per Cent Transfer Effects				
Group	*Day 1*	*Day 2*	*Day 3*	*Day 4*	*Day 5*
Constant	4.3%	3.5%	6.1%	10.9%	16.9%
Varying	1.6%	3.8%	6.0%	11.2%	14.7%

Note that the difference between the two groups was in all cases very slight and that it was not significantly affected by the reversal of practice conditions on the fifth day.

TABLE 4

Substitution Test. Average per cent transfer effects for both groups for each of the five daily tests. The transfer was in all cases positive.

	Per Cent Transfer Effects				
Group	*Day 1*	*Day 2*	*Day 3*	*Day 4*	*Day 5*
Constant	4.4%	15.6%	21.3%	18.1%	23.7%
Varying	14.4%	24.6%	27.3%	30.2%	27.2%

Note that the transfer effect was always greater for the varying group, but that the difference between the groups was much diminished on the fifth day when practice conditions were reversed.

TABLE 5

Card Sorting and Substitution Test. Difference between the constant and varying groups in the average of all the per cent transfer effects (given previously by days in Tables 3 and 4).

A. Card Sorting

Group	*Average Per Cent Transfer Effect*	*S. D. Dis.*	*S. D. Aver.*
Constant	6.2%	10.12	1.91
Varying	5.6%	9.00	1.58
	Difference	*S. D. Diff.*	*Reliability*
	0.6%	2.48	0.24

B. Substitution Test

Group	*Average Per Cent Transfer Effect*	*S. D. Dis.*	*S. D. Aver.*
Constant	14.8%	12.42	2.34
Varying	24.1%	9.29	1.64
	Difference	*S. D. Diff.*	*Reliability*
	9.3%	2.86	3.25

Note that in the card sorting the difference between the two practice conditions in their influence upon transfer effect was decidedly unreliable, but that in the substitution test the difference in favor of the varying condition was reliable.

(Note: Since the number of subjects was 7 for the constant groups and 8 for the varying, and since there were for each subject four final tests exclusive of the fifth day, when practice conditions were reversed, the total number of per cent transfer effects averaged above is 28 for the constant and 32 for the varying group.)

Discussion of Results. A. Card Sorting

In card sorting, under both the constant and the varying conditions of practice, the existence of some positive transfer effect from one arrangement to another differing in all the specific elements involved is suggested by the slight gains made by both groups in the final test of day one (although those gains are not statistically reliable), and by the data of previous investigators; namely, Bergstrom,[1, 2] Culler,[4] Pyle,[10] Brown,[3] and Liddle.[9] Such a transfer effect must be due to the development and carrying over of reactions which, because they were elicited by both the practice and the test situations, are by definition common reaction elements.

This transfer effect due to common elements was, however, extremely small when all the specific elements were changed, and when, therefore, there was more or less negative effect, here presumably interference, in connection with every one of the nine specific stimulus-response associations involved. The first sorting of the varying group on every day save the first was the most rapid for that day (Graph 1) because this one alone was free from interference. (It may be noted that Culler[4] obtained analogous results.) In the eight sortings following the first on each day, the data afford no basis for assuming that a subject in any degree overcame this interference by being constantly exposed to it; indeed the negative effects tended each day to increase, to be cumulative, rather than to diminish.

The positive transfer effect disclosed by the per cent gains (Tables 3, 4, and 5) was at no time reliably greater for the varying than for the constant group. Hence it is reasonable to conclude that neither condition of practice was superior to

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Note: It has been suggested that if the practice had been continued further, the interference effects in the varying group might finally have begun to decrease, and it is in fact extremely likely that after prolonged practice they would have done so. But since, as Culler,[4] Brown,[3] and Pyle[10] have shown, it is possible in card sorting to develop simultaneously two "mutually antagonistic habits," and since, as Culler in particular has demonstrated, interference is only an "incident" in the course of two associations' becoming automatic and may finally be completely overcome, it is reasonable to suppose that, just as in previous experiments subjects have been able to learn two arrangements alternately presented, so our subjects also would with sufficient practice have learned all of the nine different arrangements employed. But a diminution of interference due to the actual learning of the specific arrangements would, of course, not concern at all our problem as to the value of variation in preparing for *new* situations. Indeed, such learning would introduce a disturbing factor into the experiment.

the other in developing common response elements of advantage in adjustment to a new card sorting situation.

B. The Substitution Test

In the substitution test, however, the results were very different. There was a very marked positive transfer effect from one key to another differing in all of its nine specific stimulus-response elements. This transfer effect was due to elements which were common because they were elicited both by the practice and by the test situations. It was reliably greater for the varying condition than it was for the constant (Tables 4 and 5 and Graph 5). Hence it may be concluded that whatever the nature of these common elements may have been, the varying procedure was better suited than the constant was to develop them for transfer to a new substitution test situation.

The negative transfer effect which one might suppose would have resulted from the continual changing, in the varying condition, of all the specific elements of the keys used was not apparent at all until the third and fourth days (Graph 2); for on these days alone was the speed on the first key of the day the most, or approximately the most, rapid. The reason for the failure of such negative effects to show themselves earlier is probably due to the fact that the negative effect of the changing specific elements was on the first two days entirely overcome from the point of view of score by the large positive transfer effects from common elements which were then being rapidly mastered. By the third day, however, these common elements had been learned to such a degree that they ceased to contribute much to further improvement, so that the total transfer effect began to depend more and more on specific elements whose effects were presumably negative.

In order to account analytically for this greater transfer effect achieved by the varying group, it is necessary to find some common elements, mastery of which would have a significant effect on score, and which are of such a nature that they would presumably be acquired to a greater degree in the varying than in the constant condition. One such group of common elements may, we believe, be found in the spatial positions of the nine different letters on the various keys used.

Since these letters were always presented in precisely the same order, and since all the spacings between them were

exactly uniform, the subject in the varying condition came to learn the position of each letter, b, d, etc., with great accuracy. Hence he became able to find each letter on the keys immediately without any of the "trial and error" searching movements which characterized his reactions at first and so, in attacking new codes, could gain markedly in speed.

In the constant condition, however, the subject learned the one key with which he continually practiced, and so came to dispense entirely with the printed card as a guiding and controlling stimulus. He proceeded directly, as soon as a letter on the working sheet was perceived, to the writing of the appropriate number beside it without any intervening looking and finding of letters and numbers on the key. I.e., his final writing reactions became short-circuited; they became reconditioned *from* the visual stimulus of the letter-number associations given on the key *to* the letter directly, or to a verbal symbol for the number to be substituted for it. Hence he inevitably failed to master those looking and finding reactions with the degree of speed and precision to which a subject working under the varying conditions attained.

C. Comparison of Card Sorting and Substitution Test

In the substitution test the varying condition of practice was clearly superior from the viewpoint of yielding positive transfer effects to entirely new and different keys; in the card sorting, however, the varying condition was no more advantageous than the constant for yielding such initial effects to entirely new and different arrangements.

The reason for this difference is, it is suggested, the absence in the card sorting of any common elements which were (a) comparable in positive initial transfer value to new situations to those present in the substitution test, or (b) of the kind which varying conditions of practice were best suited to develop.

This conclusion suggests these further inferences:

(1) That in card sorting and simple substitution tests variation is not intrinsically, or per se, superior in initial transfer value to routine conditions of practice (even though we perhaps need not expect ever to find it reliably inferior), and that, as a corollary:

(2) The value of variation of practice conditions, in work with such material, is contingent upon whether or not the practice and test situations chance to be so constructed and related that common elements of significant initial transfer value to a new situation will be developed therein.

If these conclusions be true, then it should be possible:

(1) In the card sorting, to render the varying condition superior in initial transfer value to the constant by introducing certain new common elements to the reactions demanded, and

(2) In the substitution test, to diminish greatly or even to overcome entirely the advantage of the varying condition by eliminating therein the opportunity for the mastery of certain common elements.

To test in this way the validity of the two generalizations above was the object of Experiment II.

EXPERIMENT II

Problem. To test the validity of the conclusions, tentatively drawn in Experiment I, that in card sorting and simple substitution tests the initial transfer value of the varying as compared with that of the constant condition of practice is not intrinsic, but is rather dependent upon the construction and relation of the practice and test situations.

Subjects. Undergraduate students at New York University. The graduate students of Experiment I. (The first day records only of the latter were utilized.)

Procedure. A. Card Sorting

The materials, timing and scoring were exactly the same as in Experiment I. The method of sorting and the instructions were, for some subjects, identical with those of the first experiment. For other subjects, however, the method of sorting was varied for the purpose of introducing into the card sorting new common elements whose acquisition would presumably have a decided effect on score. The nature of this introduction may be seen from the following excerpt from the typewritten instructions given to the subjects of this group.

"Cards bearing some particular number, as 4 for example, are not, however, to be sorted into the compartment bearing that same number. Instead, the following procedure is to be adopted:

All cards bearing the number 2 go into the compartment numbered 1
All cards bearing the number 3 go into the compartment numbered 2
All cards bearing the number 4 go into the compartment numbered 3
All cards bearing the number 5 go into the compartment numbered 4
All cards bearing the number 6 go into the compartment numbered 5
All cards bearing the number 7 go into the compartment numbered 6
All cards bearing the number 8 go into the compartment numbered 7
All cards bearing the number 10 go into the compartment numbered 1
All cards bearing the number 1 go into the compartment numbered 10

The above paragraph was substituted for the sentence (in the former instructions given in Experiment I): "Each compartment will have upon it a number indicating that that is the compartment into which all cards bearing that number are to be sorted or thrown." The rest of the instructions were exactly the same as those previously described for Experiment I.

Procedure. B. Substitution Test

The methods of work, instructions to subjects, timing and scoring were exactly the same as in Experiment I. The keys were, for some of the subjects, identical with those used in that experiment. For other subjects, however, a variation was introduced in order to eliminate the presumably important common element originating from the identical spatial positions of the letters in the different keys. Instead of disposing the letters of the key each time in alphabetical order and so causing each letter to occupy each time the same spatial position therein, the nine letters were now so arranged that no letter ever occupied any one spatial position in more than one key, nor ever immediately followed the letter nearest to it in the alphabet. I.e., whereas in the former keys the letter "b" always came first at the extreme left-hand of the series and was always followed by "d," in the new keys "b" came first in the series in one key only—in other keys it was second, third, sixth, ninth, etc.—and was never immediately adjacent to "d."

Procedure. C. Common to Both Card Sorting and Substitution Test

Each subject worked one period only. This one period included, after a preliminary exercise as in Experiment I for the purpose of general orientation and habituation to the laboratory situation: (1) the "initial test," i.e., the first "regular" sorting or sheet done; (2) seven practice sortings or sheets; (3) the "final test," i.e., the last sorting or sheet done. This abbreviation of the total amount of work done by each subject was decided upon after observing that in Experiment I the results obtained were just as clearly evident at the end of the first day's period of practice as they were at the end of the fourth or even the fifth day's work.

The subjects were divided, on the basis of speed in the initial test, into the following eight groups:

Card Sorting

1. New Procedure. With new common element. Constant.
2. New Procedure. With new common element. Varying.
3. Old Procedure. Without new common element. Constant.
4. Old Procedure. Without new common element. Varying.

Substitution Test

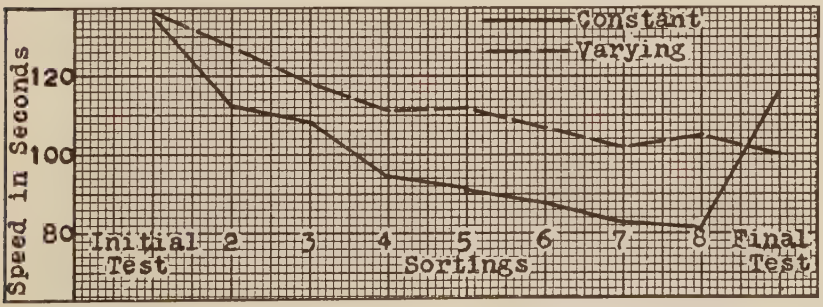
1. Old keys. With former common element. Constant.
2. Old keys. With former common element. Varying.
3. New keys. Without former common element. Constant.
4. New keys. Without former common element. Varying.

The nature of the common elements eliminated in the substitution test has already been described. In card sorting the variation in the method of sorting introduced a group of new common elements, e.g., reacting to a card numbered "2" by sorting it, not into the compartment labeled "2," but into the one labeled "1," sorting a card numbered "6" into the compartment labeled "5," etc. The acquisition of these common elements involved the inhibition of the responses most habitual to the subject and the substitution therefor of new and different ones. They were common because they were appropriate to, and were in fact elicited by, all of the nine arrangements used.

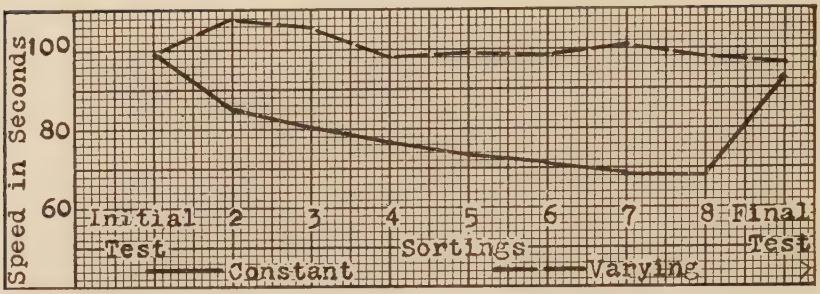
Results. Experiment II

The results of Experiment II are presented in the graphs and tables that follow. Explanatory material is given with each graph and tabulation.

The four graphs, 5, 6, 7, and 8, immediately following can best be regarded as one unit. Together they show the average speed in seconds, for both the constant and the varying groups, for card sorting with the new common elements (Graph 5), for card sorting without these elements (Graph 6), for the substitution test with the former common elements (Graph 7), and for the substitution test without those

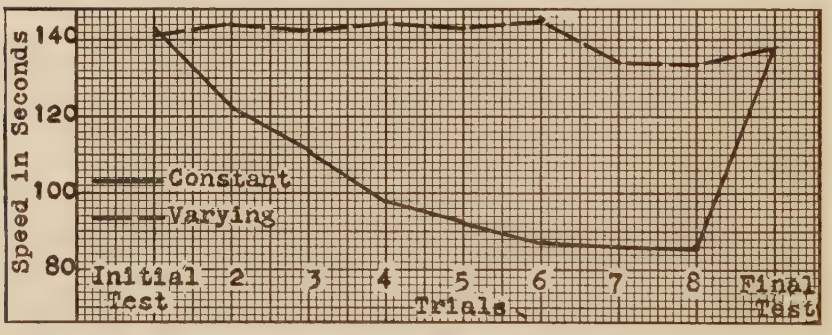


Graph 5. Average Speed, Card Sorting, with Common Elements.



GRAPH 6. AVERAGE SPEED, CARD SORTING, WITHOUT COMMON ELEMENTS.

GRAPH 7. AVERAGE SPEED, SIMPLE SUBSTITUTION TEST, WITH COMMON ELEMENTS.



GRAPH 8. AVERAGE SPEED, SIMPLE SUBSTITUTION TEST, WITHOUT COMMON ELEMENTS.

elements (Graph 8). It should be remembered that the first sorting or sheet done constituted the initial test, the last (ninth) sorting or sheet done the final test, and the sortings or sheets from the first to the eighth inclusive the practice.

Comparison of these four graphs shows the following:

A. With reference to the practice:

1. The practice curves for the constant conditions were always of the familiar negatively accelerated type.

2. The practice curve for the varying condition with common elements was negatively accelerated for the card sorting (Graph 5), but approximated a straight line for the substitution test (Graph 7).

3. The practice curves for the varying condition without common elements were without decided rise or fall, and were markedly irregular for both the card sorting (Graph 6) and the substitution test (Graph 8).

B. With reference to the speed on the final tests:

The varying condition was superior to the constant when the significant common elements were present in both the card sorting (Graph 5) and the substitution test (Graph 7). When, however, these important common elements were absent, neither condition was clearly superior to the other, either in the card sorting (Graph 6) or in the substitution test (Graph 8).

TABLE 6

Card Sorting. Average per cent transfer effects (from initial to final test). In section "B" below a plus sign before a difference shows that the varying condition yielded a greater transfer effect; a minus sign that it yielded a less.

A. Average Transfer Effects

Condition	*Number of Subjects*	*Aver. % Transfer*	*S. D. Dis.*	*S. D. Aver.*
With Common Element, Constant	17	+13.0	9.14	2.22
With Common Element, Varying	17	+25.3	8.92	2.16
Without Common Element, Constant	14	+ 6.0	7.93	2.12
Without Common Element, Varying	12	+12.2	9.13	2.35

B. Differences

Comparison	*Difference*	*S. D. Diff.*	*Reliability*
With Common Element, Varying-Constant	+11.4%	3.10	3.70
Without Common Element, Varying-Constant	— 3.8%	3.16	1.20

C. Final Difference

Between the Value of the Varying as Compared with that of the Constant, with and without Common Elements, i.e., 11.4%—(—3.8%)	15.2%	4.43	3.43

Note that the varying condition was superior in transfer value only when the new important common elements could be developed, and that the existence of a difference in its value with and without these common elements is reliable.

TABLE 7

Substitution Test. Average per cent transfer effects (from initial to final test). In section "B" below a plus sign before a difference shows that the varying condition yielded a greater transfer effect; a minus sign that it yielded a less.

A. Average Transfer Effects

Condition	*Number of Subjects*	*Aver. % Transfer*	*S. D. Dis.*	*S. D. Aver.*
With Common Elements, Constant	15	+ 4.1	10.44	2.70
With Common Elements, Varying	15	+17.1	7.32	1.87
Without Common Elements, Constant	15	+ 3.0	8.70	2.25
Without Common Elements, Varying	15	+ 2.1	7.10	1.66

B. Differences

Comparison	*Difference*	*S. D. Diff.*	*Reliability*
With Common Elements, Varying-Constant	+13.0%	3.28	3.93
Without Common Elements, Varying-Constant	— 0.9%	2.80	0.32

C. Final Difference

Between the Value of the Varying as Compared with that of the Constant, with and without Common Elements, i.e., 13.0%—(—0.9%)	13.9%	4.31	3.22

Note that the varying condition was superior in transfer value only when important common elements could be developed, and that the existence of a difference in its value with and without those elements is reliable.

Discussion of Results

The relation of these results to the particular aims of the present experiment seems clear. The problem was to test the validity of the conclusions suggested by the results of Experiment I that, in card sorting and simple substitution tests, practice under varying conditions has no intrinsic superiority in initial transfer value to a new situation to practice under constant conditions, but rather owes its advantage, when it possesses it, to the fact that the construction and relation of the practice and test situations permit, in the varying condition, a greater development and transfer of important common reaction elements. The results obtained would appear to substantiate this conclusion. When a new common element was introduced into the card sorting, the varying condition was reliably superior to the constant in its positive transfer effect to a new situation; when this common element was absent, the varying had no reliable advantage over the routine (Table 6). Similarly, in the substitution

test, when the significant common element was present, the varying condition was reliably superior as preparation for adjustment to a new situation, in this case a new key; but when this important common element was eliminated the advantage of the varying condition was likewise entirely lost (Table 7).

Or, summarizing the results of both the card sorting and the substitution test, it may be said that within the limits of the brief practice given the varying procedure gave no practice effect available for immediate transfer except where there was a common element; the constant procedure, while it gave a marked practice effect, yielded nothing available for immediate transfer except where there was a common element, and even then gave very little such effect.

However, it should be noted that in no case was the varying condition reliably inferior in transfer value to the constant.

It can not, however, be concluded that the varying condition would necessarily be superior for developing any and all common elements of distinct transfer value. Our results concern the effect, upon the efficacy of variation in practice, of the presence or absence of two particular kinds of common elements only; and for the effect of each of these an explanation can be given so specific as to render impossible any such wide generalization therefrom.

In the substitution test, as we have already pointed out, the element which largely determined the value of the varying condition of practice was the spatial position of the letters of the key. When these letters occupied the same places in all of the codes used, the eye reactions essential to a speedy discovery of the numbers to be substituted could be learned, and these reactions possessed transfer value. Their acquisition, however, proceeded more rapidly and certainly in the varying than in the constant condition of practice with consequent advantage in initial transfer value to the former. But this advantage can scarcely be attributed merely to the fact that the reactions in question were common, but rather to the fact that in addition to being common they were of a sort which only a varying condition would be likely to develop. One of the factors essential to the increase in speed in the constant condition was, of course, the learning of the particular key used. And one of the essentials to that learning was the

short-circuiting of the final number writing reactions, i.e., their reconditioning, either directly to a given letter on the work sheet, or indirectly to an intervening verbal stimulus (i.e., reacting to that letter by sub-vocal articulation of the number to be substituted for it). In either case the visual reactions essential for finding the appropriate numbers on the key were progressively eliminated. Hence they were on the whole less practiced in the constant condition than they were in the varying, where the constant change in all the individual letter-number associations made them continually necessary. Hence there was in the constant condition less mastery of reactions of value in the new test situation, here a new key, and the varying condition therefore came to possess on the average a greater positive transfer effect.

Similarly, in the card sorting, the advantage of the varying condition when the new common element was introduced was probably not due merely to the fact that the element was common, but rather to the fact that it chanced to be of a kind that a varying condition would more effectively develop. At the beginning, i.e., the initial test, in both conditions, the subjects had to react to, e.g., a card bearing a "7" by sorting it into a compartment marked "6." In the constant condition, however, the unchanging spatial location of the numbers on the compartments made possible the learning of the particular arrangement used and so the short-circuiting of the reactions, i.e., their reconditioning to, e.g., a "7," to a compartment located at a certain place instead of to a label "6" on a compartment that might be anywhere. Hence the reactions involved in the decidedly non-habitual process of finding a compartment labeled "6" after seeing a card bearing a "7" were progressively eliminated. In the varying condition, however, the continual change in the spatial location of the compartments bearing the various numbers rendered impossible any such short-circuiting, and so compelled a continual practice of the non-habitual reactions above noted. And so, since these reactions did possess transfer value, the varying condition was superior as preparation for the new test situation.

In both the card sorting and the substitution test, it should again be noted that while the varying condition was in no case reliably inferior to the constant in initial transfer value, it was distinctly superior only when (1) there was present the

possibility of acquiring common reactions of significant transfer value, and (2) when these reactions were of such a nature that the work in the constant condition, because of short-circuiting, involved less practice of them. Hence the superiority of the varying, when found, was apparently not intrinsic, but rather dependent upon complex and somewhat heterogeneous conditions.

These being the conclusions drawn from the results of Experiments I and II, the aims of Experiments III and IV will be:

(1) To investigate further the relative initial transfer value of the varying and the constant conditions of practice by employing other types of material; namely, complex substitution tests and typewriting, and

(2) By varying the situations used in each kind of material, to secure further data for determining the conditions responsible for differences in the relative value of these two modes of practice.

EXPERIMENT III

Problem. (1) To determine the relative initial transfer value, to a new key, of practice in a complex substitution test under varying and under constant conditions.

(2) By varying the substitution test situations employed, to secure further data for determining the conditions responsible for differences in the relative values of those two modes of practice.

By a "new key" is meant, as in previous experiments, one in which every specific substitution association is different from any which the subject has before encountered.

Subjects. Undergraduate students, University of New Hampshire and New York University.

Procedure

Materials. A stop-watch. An instruction sheet reproduced herewith.

"You will receive sheets of paper at the top of which will be printed eight words, each of ten letters, thus:

Fraternity	Precaution
Misfortune	Exaggerate

etc. These constitute the key.

Below these are printed in rows the initial capital letters of those eight words of the key.

The work of the test is to write to the right of each capital letter in the rows some letter, the third, the sixth, the last, etc. (as you will be directed on each sheet separately) of the key word which begins with that capital. For example, if you were using the sample key above and were instructed to write in the second letter, you would write an "i" after every "M" in the rows because "i" is the second letter of the key word which begins with "M."

When the signal to start is given, turn the sheet face up, read the sentence at the top telling you which letter of each key word to write in, then begin work at once. Try for speed. Your score is the number right in the time allowed, two minutes. If you make an error, go on to the next letter without delay; you lose time by trying to make corrections.

Begin work at the left of the first row, work across that row, pass to the left of the second row, work across that row, and so on. Take each letter as it comes in the row; do not

attempt any grouping of letters, e.g., doing all the "A's" first. If you finish the first sheet before the time is up, go on at once to the second one. When the signal to stop work is given, stop immediately."

Additional materials were a preliminary practice sheet of which the key and the first two lines of letters for which other letters were to be substituted are reproduced below:

"Write in the *last* letter.

		Inartistic				Watermelon		
		Organizing				Quadruplet		
		Knighthood				Youngsters		
		Zoological				Ventilator		
I	O	Y	K	Q	Z	W	V	Q
Y	Q	V	Z	I	W	K	Z	O"

Further materials were initial test, practice and final test sheets differing in the various subdivisions of the experiment and for the two practice groups and so described later. All the sheets save those used for the preliminary bore the same letters arranged in the same random order and identically spaced in thirteen lines of nine letters each.

Method of Work

The work was conducted as a group experiment. The subjects were given all the sheets at once, but all save the instruction sheet were turned face down. They read the instructions and asked whatever questions they wished. Then, upon the signal "go," they turned over the preliminary practice sheet and started to work upon it. After one minute they were given the signal "stop." Further questions, if any, were answered, and a brief sample of correct work upon that sheet was given orally. Then, again at the word "go," they turned over and began to work upon the first or initial sheet of the experiment proper. After two minutes they were again told to stop. This work constituted the initial trial or test. After one minute they began upon the second trial, worked two minutes, then waited one minute before starting the third trial, and so on until a total of eight trials including the initial one was completed. The last of those eight constituted the final test. The score for each trial was the number of correct substitutions.

Variations of the Practice Conditions

The experiment had three parts distinguished by differences (a) in the practice situations employed for the varying groups, (b) in their relation to those presented by the final tests, and (c) in the final tests used for both groups.

In all three parts the constant group practiced for seven trials (the initial test being the first of these seven) with sheets bearing the following key:

"Write in the *last* letter.

Arithmetic	Hydrometer
Parliament	Understand
Flirtation	Equatorial
Belaboring	Monotonous"

Following which were the thirteen lines of nine letters each of which, as has been said, were identical on all of the sheets used in both groups and in all three parts of the experiment. The first line of these letters was:

A B P M E U F H M

In all three parts the varying group had for its initial test a key identical with the above. Hence both groups always had the same initial test and so could be equated on the basis of their scores thereon.

In *Part I* the varying group practiced with keys similar to the initial test key in that the last letter of the word was always the one to be substituted, but different from the initial key in that the letter-letter associations, and consequently the words of the key, were different at each trial. In the final test for each group the following key was used:

"Write in the *fifth* letter.

Embankment	Patagonia
Bloodhound	Flourished
Headstones	Unmolested
Miraculous	Appetizing"

For each group not only the letter-letter associations, but also the position in the word of the letter to be selected and the particular words used, were different from any in the preceding practice series.

In *Part II* the keys used for the practice were, for both groups, the same as those in Part I. In the final test for both groups, however, the following key was employed:

"Write in the *last* letter.

Englishman	Plundering
Bridesmaid	Forefather
Hereabouts	Uneventful
Monomaniac	Adjustment"

Now, although the substitution associations and the words used were different from any in the preceding practice series, the position in the words of the letters to be selected was identical.

In *Part III* the final test was the same as in Part I. The varying group, however, practiced with keys which differed from each other, and from those of the initial and final tests, not only in the letter-letter substitutions employed and in the particular words used, but also in the position of the letters to be selected. Specifically, while on the initial test the key, as always, required the selection of the last letter of the word, on the second trial the selection of the sixth letter was required; on the third the selection of the seventh; on the next four trials the selection of the fourth, eighth, third and ninth respectively; and on the final test the selection of the fifth.

These differences in procedure between the three parts of the experiment may be rendered in tabular form as follows:

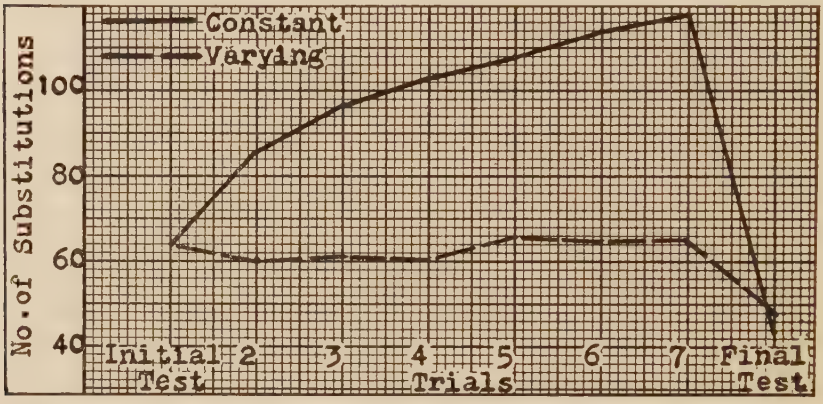
	Letter selected in		
	Initial Test	*Intervening Practice*	*Final Test*
Part I			
Constant	Last	Last	Fifth
Varying	Last	Last	Fifth
Part II			
Constant	Last	Last	Last
Varying	Last	Last	Last
Part III			
Constant	Last	Last	Fifth
Varying	Last	Different each trial	Fifth

The *keys* used were not changed in the constant condition until the final test, but in the varying condition were changed at each trial.

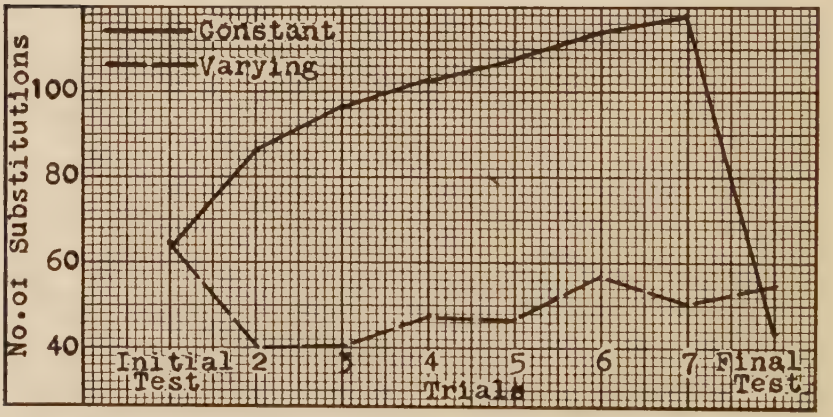
Results. Experiment III

The results of Experiment III are given in Graphs 9, 10, and 11 and in Table 8 following.

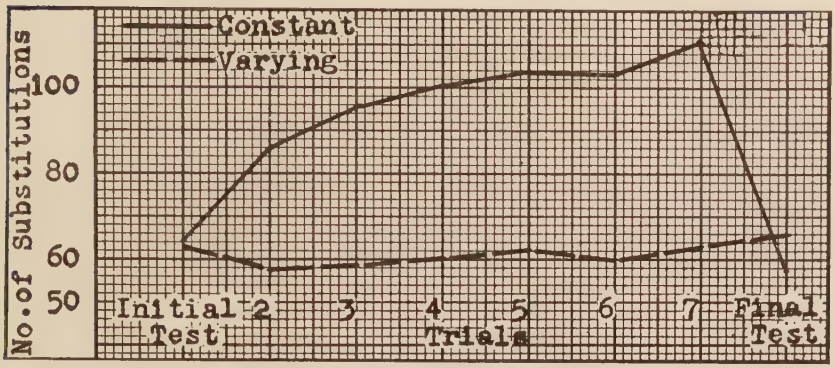
With respect to the graphs, we may note that for the constant condition the practice curve previous to the final test was in all cases of the negatively accelerated type, whereas for the varying condition it was in all cases rather irregular, without definite or consistent slope in either direction. It should be further noted, however, that in all three parts of the experiments the score of the varying group on the final test was superior to that of the constant, and that this difference between them was least in Part I, more in Part II and greatest of all in Part III.



Graph 9. Average Number of Substitutions Correct, Complex Substitution Test, Part I.



Graph 1. Average Number of Substitutions Correct, Complex Substitution Test, Part II.



GRAPH 10. AVERAGE NUMBER OF SUBSTITUTIONS CORRECT, COMPLEX SUBSTITUTION TEST, PART III.

TABLE 8

Complex Substitution Test, all three parts. Per cent transfer effects, averages and differences.

Practice Condition	*Number of Subjects*	*Average % Transfer*	*S. D. Dis.*	*S. D. Aver.*
		A. Average Per cent Transfer Effects		
Part I. Varying, last letters.		Final test, fifth letter.		
Constant	30	—32.6	11.37	2.07
Varying	28	—24.0	21.91	4.14
Part II. Varying, last letters.		Final test, last letter.		
Constant	25	— 9.0	13.15	2.63
Varying	30	+ 4.7	17.47	3.90
Part III. Varying, changing letters.		Final test, fifth letter.		
Constant	30	—32.6	11.37	2.07
Varying	25	—13.6	13.70	2.74

B. Differences in Average % Transfer, Varying-Constant
The varying is superior by the per cents given

	Difference	*S. D. Diff.*	*Reliability*
Part I	8.6%	4.63	1.9
Part II	13.7%	4.13	3.3
Part III	19.0%	3.43	5.5

C. Comparison of the differences given above, which will show the amounts by which the superiority of the varying group differs under different experimental conditions.

Part II—Part I	5.1%	6.20	0.8
Part III—Part I	11.4%	5.67	2.0
Part III—Part II	5.3%	5.37	1.0

(Note: The 30 subjects in the constant conditions in Part I and Part III are the same individuals. The experimental conditions in those two parts differed only with respect to the work of the varying group.)

These results may be summarized as follows:

1. The transfer effect was always negative save for the varying group in Part II.

2. The varying condition was always superior to the constant in initial transfer value.

3. The superiority of the varying was greater in Part II than it was in Part I, and was greatest of all in Part III.

Discussion of Results

(1) For the fact that the transfer effect was, in five cases out of six, negative rather than positive we have no adequate explanation. In any given transfer situation there might be a carrying over of interfering as well as of common elements, and in general it would be impossible to make any a priori prediction as to their relative effect on performance in the test. One probable source of the magnitude of the negative transfer effects in Parts I and III is the fact that it is presumably more difficult to find quickly the fifth letters of the words, which the final tests in those two parts required, than it is to find the last letters, which the initial tests demanded. But this supposition does not apply to Part II where the transfer effect for the constant condition was still negative, though indeed much less in amount; and beyond this we do not find it possible to go. In any case, however, our problem concerns the relative transfer value of varying and constant conditions and not the negative or positive characteristics of the transfer effects found.

(2) The superior transfer value of the varying condition seems to require in each of the three parts a different type of explanation.

(a) In Part I its superiority was least and, partly because of the extreme variability of the varying group, was not wholly reliable. Why, however, it should have been superior at all is by no means clear. The varying group had, of course, more practice in reading the key words and finding therein the letters to be substituted. But since the key words were each time different, and the practice was in selecting last letters and not fifth ones as the final test required, it is difficult to suggest exactly what common elements, if any, were more developed in the varying condition. It may be that the vary-

ing group developed a coordination of looking and writing reactions in which the constant group, since they tended to learn their one key and so to look less often, would be less practiced. Something of the sort was observed to occur with some of the subjects who worked under the varying condition in the simple substitution tests of Experiment I.

(b) In Part II the varying was not only reliably superior in transfer value to the constant, but also was more superior than it was in Part I (although this difference between the differences is not in itself reliable).

Its superiority to the constant seems explainable on grounds similar to those advanced in accounting for its superiority in the simple substitution tests with significant common elements in Experiments I and II. In both the initial test, the practice and the final test the last letter of the word was always the one selected for substitution; and to find this last letter with maximum speed required the development of certain specific looking and finding reactions. Since, however, the constant group tended to learn the one particular key used, their reactions tended to become short-circuited (as described in the case of the simple substitution tests, p. 31) with consequent elimination or abbreviation of these "searching" responses. The varying group, however, since they had each time a new key, were obliged to go through those reactions in every trial. Hence, being more practiced in them, they were superior in a final test in which such reactions were essential.

The fact that the superiority of the varying group was greater in Part II than it was in Part I seems to have been due to the presence in Part II alone of the probably highly significant common element described above; namely, the identity of the spatial position in the words of the letters to be selected and the consequent similarity of the reactions involved in making such selection. There do not appear to have been in Part I any common elements which had such positive effect on score and which the varying condition could better develop.

(c) The superiority of the varying group in Part III seems, however, to require a different type of explanation.

In all previous experiments an effort was made, as we have said, to have every one of the situations presented to the varying group as dissimilar from the final test situation as was the

one situation with which the constant group worked. I.e., any obvious specific similarities or identities between practice and test situations were, so far as could be contrived, no greater in frequency or significance for one group than they were for the other. This procedure was adopted because it was desired that all common elements (so far as an objective survey of the situations to be used could disclose them) should be *potentially* present in equal degree for both groups. For otherwise any superiority to which the varying group might attain would be easily explainable on the basis of specific identities of procedure which the constant group had never had opportunity to develop.

In Part III of this third experiment, however, this principle was for the time abandoned, and the practice and test keys were so constructed and related that there would be specific similarities present for the varying group but absent for the constant. These similarities consisted, we believe, in the employment with the varying group of keys requiring the selection of such letters as the third, fourth, sixth, and seventh. The assumption was that practice in finding these letters would have more transfer value to a key requiring the finding of the fifth letter than would practice in finding last letters only, to which the work of the constant group was restricted. If so, then one would find for the varying group a superiority not due, as in previous cases, to the development of elements common to the entire practice-test series, but of elements which were common to certain ones of the practice situations and the test situation only and which were likewise potentially present for the varying group alone. Whether the above explanation be considered adequate or not, at least the varying group was markedly superior under just those circumstances in which such superiority was to be expected.

(d) Some of the subjects, in order to find the fifth letters quickly, employed the stratagem of drawing a vertical line through the key words at a point just before or just after those letters, the result being that the letters to be selected became visually more distinct. Inspection of the final test sheets showed that this procedure was employed by ten individuals in the varying group but by only one in the constant. Examination of preceding practice sheets of the varying group showed that in many cases this device had been adopted early in the practice and had been continued in most

cases up to and through the final test work. Since the constant group had always to select the last letters, no such visual guide was ever introduced at any time prior to the final test. This technical device became, then, for certain of the varying group a new common element which was initiated during the practice and transferred to the work in the final test. If any significant positive influence on final score can be attributed to it, one would have therein a partial explanation of the superiority of the varying group in this part of the experiment.

Why the superiority of the varying group should be greatest in Part III of the experiment remains doubtful. If any certainty existed that the above analyses revealed all the common elements which were better developed by the varying group, then one could simply say that those developed in Part III possessed more transfer value than those developed in Parts I and II. But in the absence of such assurance no definitive solution of the problem can be ventured.

(3) In summary, it may be said of the results of Experiment II that, in the complex substitution tests used, the varying condition was always superior in transfer value to the constant; that the degree of its superiority was, however, measurably influenced by experimentally introduced variations in the practice and test situations employed; and that, in explanation of both its superiority in general and of the variations to which that superiority was subject, specific bases in the unequal presence and development of various common elements can be suggested. In general the results show that, as has been inferred before, the relative values of constant and varying practice as preparation for initial adjustment to a new situation are decidedly variable, and depend upon analyzable differences in the nature and relation of the practice and test situations employed.

EXPERIMENT IV

Problems. 1. To determine, for certain typewriting situations, the relative initial transfer value to a new situation of the constant and the varying conditions of practice.

2. By variation in those situations, to investigate further the circumstances responsible for differences in the relative transfer value of those two practice conditions.

Subjects. Undergraduate students, New York University.

PART I

Materials. A portable Corona typewriter, 1920 model, with three-tier keyboard. Green rubber caps, of the standard make manufactured by the Peerless Key Co., bearing letters and numbers in white and attachable to any key. Cards bearing the copy. A screen set up over and in front of the typewriter, of a size suitable to display the copy and to conceal the subjects' typing from their view, yet not to interfere with the action of the typewriter keys. A stop-watch.

Procedure. The subjects first read the instruction sheet reproduced herewith.

"The work in this experiment is simply to type numbers from 0 to 8 inclusive. The key to be struck for each number is indicated by the numbers on the green caps which have been placed over those originally belonging to the typewriter. A card showing the *order* in which the numbers are to be typed will be set up in front of you. Try not to lose your place on it as you work. Note that, in order to aid you in keeping the place, each line of numbers begins with a different number; and that, furthermore, the first line begins with a 1, the second with a 2, etc. Note also that there are 8 lines in all and 9 numbers in each line, so that to type each card requires the printing of 72 numbers only. Since the typewriter keys themselves continue to print the same numbers or letters regardless of the position of the green caps, it would only be confusing for you to see your work as you go. Hence the sheet on which you are actually typing is concealed from view. (It is, however, inspected and corrected afterwards according to a special key.)

"Begin to work when the signal is given. This signal will be the removal of the sheet concealing the green-capped keys. Stop work when you have finished typing the numbers on the card. Work as fast as you can, but avoid errors. If, however, you make an error, go right on to the next number; you would only lose time by trying to correct it.

"The machine will each time be so set that you need not make any adjustments whatever in the course of any one trial. All you have to do is to type the numbers quickly and in the order shown on the card.

"The work of the experiment proper continues for nine separate trials, i.e., for nine printings of the 72 numbers on the card. It is preceded by a preliminary practice in which you type the letters A to J inclusive instead of numbers. The work in this preliminary proceeds in exactly the same way as does the regular work described above."

The copy consisting, as stated in the instruction sheet, of 72 letters arranged in eight lines of nine each, first typed on a sheet of paper 4 x 3.75 inches, then inked over, was affixed to the screen. Rubber caps bearing the letters

D J G A F C H B E

were placed in that order upon the second tier of keys. At the signal the subject started typing. His score was the time in seconds required to complete the copy; one second was added to the time for every error made. This constituted the preliminary practice.

The subject then proceeded, after an interval sufficient to permit changing of caps and copy, to the initial test, or first of the practice series. The work in this was exactly as described for the preliminary above, except (1) that the copy was 72 *numbers* arranged and presented as before and with no one number appearing more than once in any one line; and (2) that the caps used were now numbered instead of lettered and were affixed to the keys of the upper tier instead of to those of the middle one. The order in which they were placed was such that no two numbers immediately adjacent in the numerical series ever appeared on immediately adjacent keys. A sample of such an order is 4 0 7 1 6 3 8 2 5. After this initial trial was completed, the subject was allowed a rest interval of one minute.

In the constant condition this initial trial was followed by seven other practice trials identical in all respects with the initial one save that the copy, although precisely like the

initial in all the details of arrangement and construction, differed from it in the order of the numbers in each of the eight lines. (These changes were made in order to eliminate the common element of memorizing a particular copy.)

In the varying condition the initial trial was followed by seven practice trials differing from the first in that (1) the copy was each time changed in the manner described above for the constant condition (the same series of copies was in fact used for both practice conditions); and (2) the arrangement of the green numbered caps placed on the upper tier of keys was different for each trial. The changes in arrangement were so made that no one numbered cap was ever placed twice on the same key; i.e., no such cap ever occupied twice the same spatial location in the tier.

After the completion of the eight practice trials noted above (the "initial test" was, of course, also the first of those eight), all the subjects proceeded to the last trial or the final test. This trial differed for all the subjects from any preceding one in that (1) the copy differed from any used in any practice trial in the same way that the copies used in the several practice trials differed from each other; and (2) the arrangement of the green caps differed from any used in any practice trial in the same way that the arrangements used in the practice trials of the varying condition differed from each other.

Hence the two groups of subjects had the same preliminary typing, the same initial and the same final tests, and differed, therefore, only in the nature of the intervening practice.

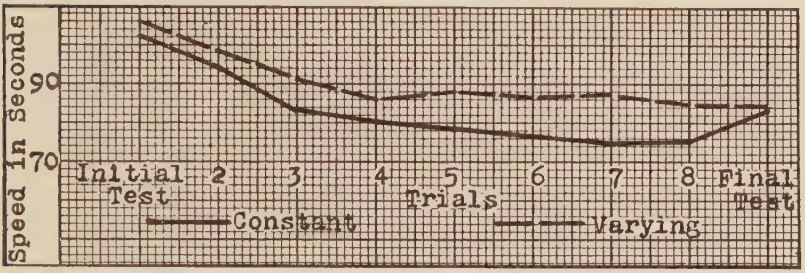
The interval between any one trial and its immediate successor was, in both practice conditions, always one minute.

A given subject was assigned to one practice group or the other in accordance with his speed on the initial trial, the object being to obtain groups whose average speed on that trial should be approximately the same. The proportion of individuals who had had previous experience with typewriting was about the same in both groups.

Results

The results of Part I of this experiment are given in Graph 12 and Table 9 following.

With respect to the graphical results, we may note that the practice curve for the constant condition was of the negatively



GRAPH 12. AVERAGE SPEED, SIMPLE TYPEWRITING.

accelerated type throughout, whereas that for the varying condition was approximately a straight line up to the fourth trial after which it became somewhat irregular. It should further be noted that the speed on the final test was almost identical for both groups.

TABLE 9

Simple Typewriting. Per cent transfer effects, averages and difference.

Practice Condition	*Number of Subjects*	*Average % Transfer*	*S. D. Dis.*	*S. D. Aver.*
Constant	16	+18.0	7.75	1.94
Varying	18	+20.7	10.13	2.40

Comparison of Transfer Value, Varying-Constant

Difference	*S. D. Diff.*	*Reliability*
2.7%	3.09	0.87

Discussion of Results

The results of Part I of this experiment can be briefly summarized as follows: That while the varying condition was not inferior in transfer value to the constant it was likewise not reliably superior to it.

In other words the relative transfer values of these two practice conditions appear to be, in this simple typewriting situation, very similar to what they were in the card sorting and the simple substitution test "without common elements" of Experiments I and II. Since there was in both conditions a reliable positive transfer effect, common elements were certainly developed in the practice and transferred with advantage to the new arrangement used in the final test. But evidently the varying condition was little if any more suited than the constant was for their acquisition.

This conclusion having been drawn, it seemed profitable to introduce new common elements into the typewriting (just as was done in the card sorting in Experiment II) to see whether or not these changes would bring about any changes in the relative initial transfer value of the two conditions of practice.

PART II

Special Problem. To determine the effect, upon the relative initial transfer value of the constant and the varying conditions of practice, of the introduction of new and complex common elements into the typewriting situation.

The *materials* and *procedure* were exactly the same as in Part I except:

(1) Instead of having for the copy a card bearing 72 numbers arranged in eight lines of nine each, the subject had a card bearing eighteen numbers disposed in two lines of nine each, which he copied twice in the preliminary trial and three times in each of the succeeding trials from the initial to the final test inclusive. This change in the copy was introduced to eliminate the frequent confusion and delay due to the subject's losing his place in the more complex copy used in Part I. Since the order of the numbers in each of the two lines differed each trial in these new cards also, it does not seem probable that this minor change introduced any important new common elements not present in Part I.

(2) Instead of typing directly the numbers of the copy, the subject followed these instructions:

"But note that on this card" (i.e., the copy) "you do not have letters but numbers. You must first read a number on the card, then find, on the key below, the letter that goes with that number. Then only do you know what letter to type. In other words you read numbers, but type letters, and the key shows you what letter is to be substituted for each number read."

The rest of the instructions were identical with those given in Part I. In other words, a substitution test code was introduced so that the subject, after reading a number from the copy, had to find on the code the letter to be substituted for it; then only was he able to select the key to be struck.

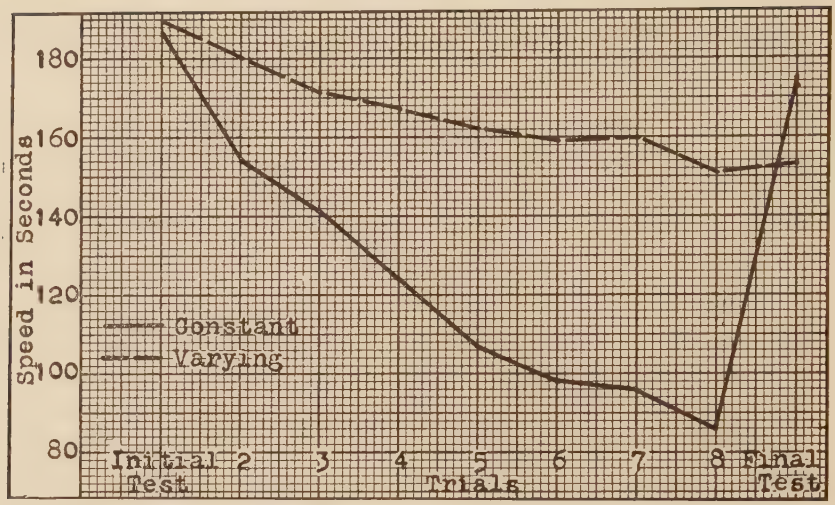
These codes were attached to the screen directly below the copy. In the code used in the preliminary practice the letters R T X S M Y P K U were employed. In the codes used for the nine regular practice and test trials following, the letters A to I inclusive were utilized. The various codes were so constructed that (1) no letter was ever associated twice with the same number; and (2) no number ever occupied twice the same spatial position in the series of nine numbers appearing in each code. Hence they duplicated in all details, except the particular letters used and the fact that they were number-letter rather than letter-number codes, the keys used in the simple substitution test without common elements of Experiment II. In all cases the numbers and letters were first typed, then inked, and the details of size and spacing were throughout the same.

In the constant condition the subject began and continued with the same code and the same cap arrangement. On the final test, however, both the code and the arrangement differed in all specific details from the one with which he had been working. In the varying condition the subject had at each trial both a code and an arrangement differing in all specific details from any that he had previously encountered.

The principles governing the arrangements of the green caps (this time bearing letters instead of numbers) on the upper tier of keys, the time intervals and the scoring were precisely the same as in Part I.

Results

The results of the second part of Experiment IV are given in Graph 13 and Table 10 following. The graph shows that the practice curves for both the constant and the varying conditions were of the negatively accelerated type. It should, however, be noted that the speed of the varying group on the final test was markedly superior to that of the constant.



GRAPH 13. AVERAGE SPEED, COMPLEX TYPEWRITING WITH INTERPOLATED SUBSTITUTION TEST.

TABLE 10

Complex Typewriting, with interpolated substitution test. Per cent transfer effects, averages and difference.

Practice Condition	*Number of Subjects*	*Average % Transfer*	*S. D. Dis.*	*S. D. Aver.*
Constant	16	+ 6.8	9.47	2.37
Varying	16	+17.9	8.89	2.22

Comparison of Transfer Values, Varying-Constant

Difference	*S. D. Diff.*	*Reliability*
11.1%	3.25	3.4

Comparison of the Difference in Transfer Values Found in Parts I and II

Difference, varying-constant, Part I, simple typewriting		2.7%
Difference, varying-constant, Part II, complex typewriting with interpolated substitution test		11.1%
Difference, Part II—Part I		8.4%
The S. D. of the last difference	4.49	
The reliability of the last difference	1.9	

Discussion of Results

In Part II of this typewriting experiment the varying condition was reliably superior in initial transfer value to the constant. It is not, however, easy to discover the precise nature of the common elements whose greater acquisition in the varying condition would account for that difference.

The results of Experiment II showed that the varying con-

dition was not reliably superior to the constant in work with simple substitution test keys, approximately identical with those used in this experiment, in which the spatial position of the letters and numbers was constantly varied. Furthermore, the results of Part I of this experiment showed that the varying condition was not reliably superior in typewriting situations in which the arrangement of the caps was changed in a manner identical with that employed in this section of the experiment. Hence it seems doubtful whether the superiority of the varying condition just found can be attributed to common elements present and developed by the work either with changing codes or with changing key arrangements separately considered. If this be true, then the common elements better developed by the varying condition must be found, not in the work with the codes or the arrangements taken separately, but rather in the reactions involved in passing from the copy to the code, or from the code to the key arrangement, or both; for these seem to have been the only common elements which were more practiced in the varying than in the constant condition (the practice in reading the copy was, of course, identical for each) and whose explanatory value is not more or less negated by the results of previous experiments. The subjects themselves, when asked to account for their improvement under the varying condition, most frequently mentioned "getting used to looking" as the factor responsible. And while such casual and superficial reports have no more than a suggestive value, they would nevertheless lend some support to the only explanation which seems to us tenable; namely, that in the searching reactions involved in passing from copy to code and from code to keys are to be found the common elements whose development was responsible for the superiority of the varying condition. At any rate such reactions would, for reasons already abundantly discussed, be more practiced in the varying than in the constant condition of work.

An explanation of this sort would also account for the fact that the superiority of the varying practice was greater under the conditions present in Part II than it was under those present in Part I. For only in the former were the substitution codes introduced and the opportunity given for developing any of the reactions involved in their use.

DISCUSSION OF RESULTS

A. RESTATEMENT OF PROBLEMS AND METHODS

1. To compare the value, from the viewpoint of immediate subsequent adjustment to a new situation, i.e., the initial transfer value of varying and constant conditions of practice.

2. To discover the factors responsible for differences in that transfer value, if differences should be found.

Four kinds of situations were employed: card sorting, simple and complex substitution tests, and typewriting. The general *procedure* was in all cases the same: a preliminary practice, an initial test, a series of six or seven practice trials, a final test. In each type of situation used the subjects were divided, on the basis of their scores on the initial test, into two groups presumably equal in ability. One of these groups practiced under the constant condition using the same key, code or arrangement throughout; the other practiced under the varying condition using in each practice trial a different key, code or arrangement. Finally both groups were given a final test on a key, code or arrangement differing in all of its specific elements from any with which they had previously worked. The differences in score, computed in per cent terms, between the initial and the final tests were considered to constitute a measure of the transfer value of the intervening practice. (Of course the work on the initial test itself was responsible for some of this "transfer effect.")

B. PRELIMINARY SUMMARY OF RESULTS

The combined results, derived from nine such comparisons of the relative initial transfer value of the constant and varying conditions of practice, are as follows:

1. In the card sorting, the simple substitution test and the typewriting six comparisons were made. In the three cases in which the possibility of developing a particular common element or group of elements was present, the varying condition was reliably superior in initial transfer value. In the three cases in which that possibility was absent its value was not reliably different from that of the constant.

2. In the complex substitution test three comparisons were made. In all three the varying condition was superior to the constant, but the magnitude and the reliability of this difference were increased when new common elements were introduced.

C. INTERPRETATION OF RESULTS

1. Although the varying condition was never reliably inferior to the constant, it was, in three comparisons of the nine, not reliably superior. Hence its advantage in the other six cases can scarcely be attributed to the mere intrinsic fact of variation itself, or to any such obscure factors as "getting used to change" and the like.

2. Since its advantage did differ measurably under different conditions, any explanation thereof must take into account the precise nature of those conditions; i.e., it must involve some analysis of the practice and test situations employed, of the reactions which they elicit, and of the relations of those situations and reactions to one another.

3. Such an analysis was undertaken in each of the nine comparisons made. The following conclusions resulted: In the card sorting, the simple substitution test and the typewriting the varying condition was reliably superior only when there was present an important common element of such a nature that it would be developed in the varying condition but, because of short-circuiting, would be less practiced in the constant condition (pages 31, 50-51). In the complex substitution test the reasons for the constant superiority of the varying condition were not always clear. The differences in the degree of the superiority, however, could be related, in one case to the introduction of a common element similar in nature and effect to that introduced in the simple substitution test; in another case to the presence in the varying series of common elements not potential at all in the constant series, and to the development by certain subjects in the varying series of a possibly advantageous modification of technique (pages 40-43).

4. It seems possible to summarize as follows the characteristics of the common elements whose presence brought about an *increased* advantage to the varying condition in the card

sorting, the simple substitution test, the complex substitution test in Parts II and III and the typewriting.

(a) In four of the five cases, namely, in the card sorting, the simple substitution test, Part II of the complex substitution test and the typewriting, these common elements apparently belonged to the class of reactions commonly characterized as being of a looking, searching, exploring, finding type; as reactions which are in a sense preparatory for, or at least preliminary and antecedent to, the final reactions of throwing a card, writing a number or letter or striking a typewriter key. Such reactions were demanded in new situations in the materials employed, and were susceptible to improvement by practice with consequent favorable effect on score in such situations. The varying condition compelled their continual practice; the constant, on the other hand, made possible a short-circuiting of such a nature that these exploratory reactions were progressively eliminated and so were as a whole less practiced than they were in the varying condition.

(b) In one case, Part III of the complex substitution test, the varying condition induced in some subjects the development of a special technique whose effect was the facilitation of these exploratory reactions. This technical development was not, however, as in the other four cases compelled by the very nature of the situations reacted to, but was rather an innovation which any subject might or might not adopt.

(c) In one case, also in Part III of the complex substitution test, the situations of the varying series were so constructed as to possess, with respect to the final test situations, certain specific similarities of which the situations in the constant series were wholly devoid. The very considerable superiority of the varying procedure in this section of the experiment may perhaps be in part attributed to this factor.

D. GENERALIZATIONS

With respect to the scope of the generalizations which these conclusions permit, it should be noted:

(a) That their scope is limited by the fact that in all the experiments the period of practice was very short, and that the reactions demanded were of a sensori-motor type so sim-

ple that a marked improvement therein could be attained in less than an hour's practice.

(b) That their scope is also limited by the fact that the test of transfer value was a test of *immediate* transfer effect to an *initial* adjustment to a new situation. There was at no time any measure of delayed transfer effects, nor of effects which might have been evident only if the subjects had been given more than one trial in the final test situation. (Obviously, however, if they had been given more than one trial therein, the situation would no longer have been genuinely new.)

(c) That their scope is further limited by the fact that the variation was, as described on page 9, of a rigidly controlled sort, and hence of a kind not apt to be maintained in any series of chance variations. As we pointed out on those earlier pages, one would expect that in a sequence of uncontrolled variations there would be at times a recurrence of identical situations, which might promote a short-circuiting disadvantageous to adaptation to a new situation; and on the other hand one would also anticipate that there would sometimes be variations which would possess partial identities with the final new situation of such magnitude that transfer of specific reactions on a large scale could occur with, one would presume, a marked positive effect. Which of these two factors would, in any given case of uncontrolled variation, have the greater influence on transfer effect and so upon the relative transfer value of varying and constant conditions of practice, it would of course be impossible to determine a priori.

(d) Nevertheless it seems probable that at least this generalization might be permitted: That, in any sphere of work, in so far as *preliminary exploratory reactions* are of significance to performance, the constant condition could scarcely be expected to surpass the varying in positive transfer effect to a genuinely new and different situation, and might indeed be expected to be distinctly inferior to it. The learning that takes place in the constant condition must logically be due, either to the speeding up of advantageous reactions already present, or to short-circuiting by the elimination from the total response of reactions which have become superfluous, so that a fixation of highly specific response totals would typi-

cally ensue. It seems reasonable to assume that exploratory reactions would in general be among those most likely to be eliminated, and that, in consequence, in spheres in which such preliminary adjustments are of importance, the individual practiced in a constant condition would be relatively ill-prepared for change. However, such a generalization devolves upon logical grounds only and is not demanded by our data.

E. REMARKS ON METHODOLOGY

With reference to methodology it seems to us that the fact that, by making known variations in the situations employed, we were able not only to relate difference in transfer effect to them, but also to predict those differences (page 24) and to make them intelligible and explainable, strongly suggests the value in transfer experiments of the isolation and control of the elements of the situations involved. The literature in the field of transfer contains numerous studies in which the respective transfer value of work in various specific practice situations upon performance in various specific transfer situations is, to be sure, reliably determined. But in many of these experiments controlled variations of such a nature as to disclose what factors were responsible for the differences in transfer effect found are lacking. In such cases the significance of the experiment tends to be limited strictly to the practical or other import of the particular comparisons made, and in consequence to lack any general or theoretical value. Certainly in the present investigation the absence of such variations would have rendered impossible the identification of the elements responsible for the advantage of the varying condition of practice (when it existed), and so would have made our results incapable of any but the most theoretical interpretation.

FINAL SUMMARY

The relative value from the viewpoint of immediate subsequent adjustment to a new situation, i.e., the initial transfer value, of constant (or routine) and varying (or changing) conditions of practice was investigated in card sorting, substitution tests and typewriting, each so modified as to include both simple and complex types. In six of the nine comparisons made, the varying condition of practice was superior in initial transfer value. Since, however, it was not always superior, its advantage cannot be attributed to the value of variation per se, but rather must be ascribed to the presence in those six cases of common elements of such a kind as to be both important for adjustment and better developed by the varying condition. As to their nature, the controlled variations in the practice and test situations employed, together with the analysis which the results thereof suggested, lead to this conclusion: That the superiority in initial transfer value of the varying condition was, when found, due to the greater practice therein of exploratory reactions essential for efficient preliminary adaptation to the new situation and, in one case, to the development on the part of some subjects of a special technique having for its effect the facilitation of those reactions.

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